CHANNEL DEVELOPMENT OF THE THAUMASIA REGION OF MARS BASED ON DETAILED MAPPING AND GIS ANALYSIS. J. M. Dohm, K. L. Tanaka, and T. M. Hare, U.S. Geological Survey, Flagstaff, AZ, 86001; jdohm@flagmail.wr.usgs.gov.

An intensive study of channels in the Thaumasia region [1] was undertaken to determine their causal, temporal, and spatial relations with the surrounding geology and other structures. We mapped and dated (by stage; see [2]) thousands of channels (for example, see Fig. 1) and other erosional and tectonic structures as part of a comprehensive, multilayered GIS database of geologic, paleoerosional, and paleotectonic information for comparative analysis [2-4].

Our data indicate that the number and length densities of channels in the map region declined substantially during the Hesperian and Amazonian Periods (Fig. 2), which corresponds with the results of Scott et al. [5]. Additionally, patches of Noachian channels of stage 1 are distributed widely, whereas the majority of Hesperian channels of stages 2 and 3 are mainly near volcanoes, highly faulted areas, and large impact craters. In many areas, resurfacing and intense faulting may have obscured older channels.

The decline of valley systems is commonly viewed as indicative of a change from a warm, wet climate to a colder, drier one [6-7]. A large number of randomly distributed channels of stage 1 dissect many Noachian surfaces in the southern part of the Thaumasia region, which largely include those along the southwest edge of the Thaumasia plateau, eastern margin of the Coprates rise, and near large rift systems and impact craters. The widespread distribution of Noachian valley forms may be attributed to rainfall or sapping processes of a warm, wet climate and high geothermal gradient early in martian history, or widespread impact bombardment and heating [6, 8-11]. Craddock and Maxwell [12] determined that the densities of fresh craters in highland terain generally decrease at progressively lower elevations, which they interpreted to indicate an extended period of atmospheric thinning and cooling. By comparing channel sources and their relative age of formation to their elevation, Dohm and Scott [13] concurred with the ideas that volatiles gradually migrated to lower elevations, that Mars' early atmosphere was relatively thick, and that a gradual thinning may have resulted both in fewer channels forming at higher elevations and in a global decrease in the rate of channel formation. On the other hand, their varied occurrences may also indicate that several different processes may have contributed to channel formation, including (1) local hydrothermal activity due to heating by intrusions [e.g.,14] and impacts [15]; (2) increased hydrologic activity due to tectonic deformation [e.g.,16]; and (3) local condensation and precipitation of water vapor from volcanoes [17].

During the Late Noachian and Early Hesperian, channels developed near volcanoes, rift systems, faults, and impact craters, which suggests that local hydrothermal activity due to intrusions, tectonic deformation, and impact craters produced channel systems. For example, a well developed channel system, Warrego Valles, heads near a large rift system that consists of faults of stages 1 and 2. The Late Noachian/Early Hesperian (stages 2-3) channel system dissects Noachian and Early Hesperian rock materials and modifies and destroys mainly older fault systems of stage 1. The temporal and spatial relations of the channel system to the rift system and surrounding geology suggest that Warrego Valles formed concurrently with volcanotectonic activity. An intrusive body with associated prolonged heating and tectonic activity seems more likely to have resulted in the formation of the channel system than rainfall. Other examples include: (1) a network of troughs that head near faults, grabens, and large depressions of the southern part of the Coprates Rise; (2) a distinct channel that heads near a fault (near 39.0_S., long 101.0_) along the southwest margin of the Thaumasia plateau northwest of a large shield volcano; (3) channels that dissect the flanks of volcanoes of the Thaumasia region; (4) a well-defined channel system that is upslope and to the northeast of Lowell impact crater [18]; and (5) valley forms (near 39.0_S., long 80.5_) that occur along preexisting structure downslope of a large Hesperian impact crater .

In the Argyre province, however, Early Hesperian resurfacing of Noachian units resulted in large valley forms, irregular depressions, drainage basins comprising valley networks, and highly subdued ridges of all shapes and sizes that are not evidently associated with volcanoes and highly faulted terrains. These surfaces may have been modified by eolian, mass-wasting, sapping, and fluvial, and (or) glacial processes [19, 20], which may have been more pronounced, because Argyre may have acted as a catchment basin for volatiles at lower elevations with respect to the Thaumasia plateau.

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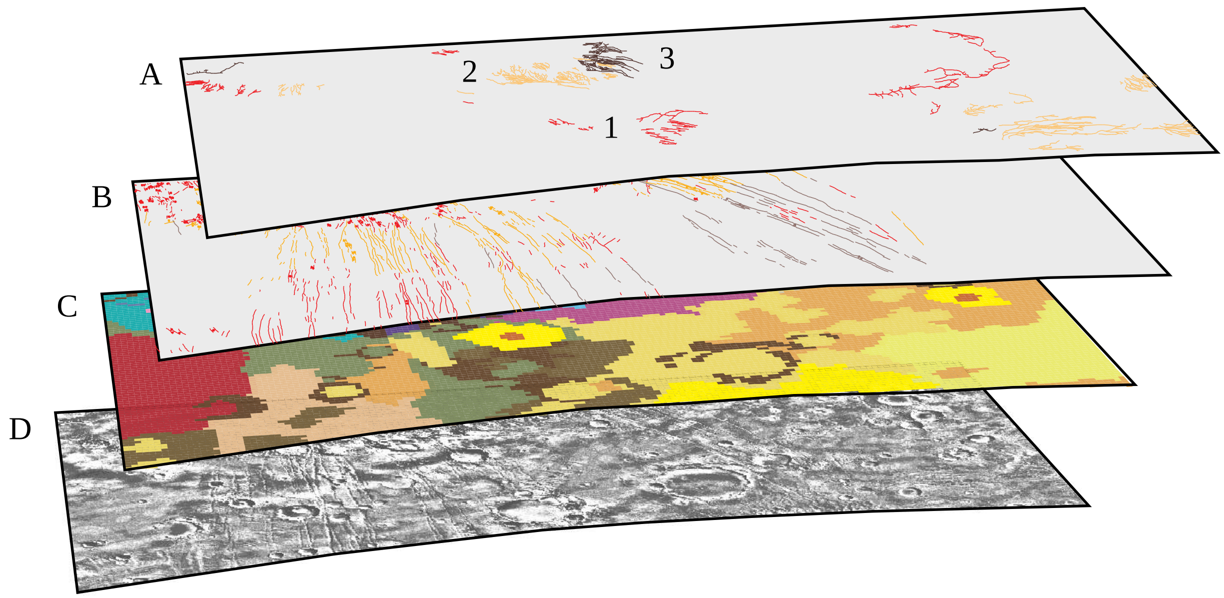

Figure1. Multilayered GIS database of the southern margin of the Thaumasia Plateau of Mars. Layers include channels (A), faults (B), geologic units (C), and a Viking photomosaic (D). Layer (A) also shows the stage designations for color-coded sets of channels (1-3) (for more information on stages see [2]).

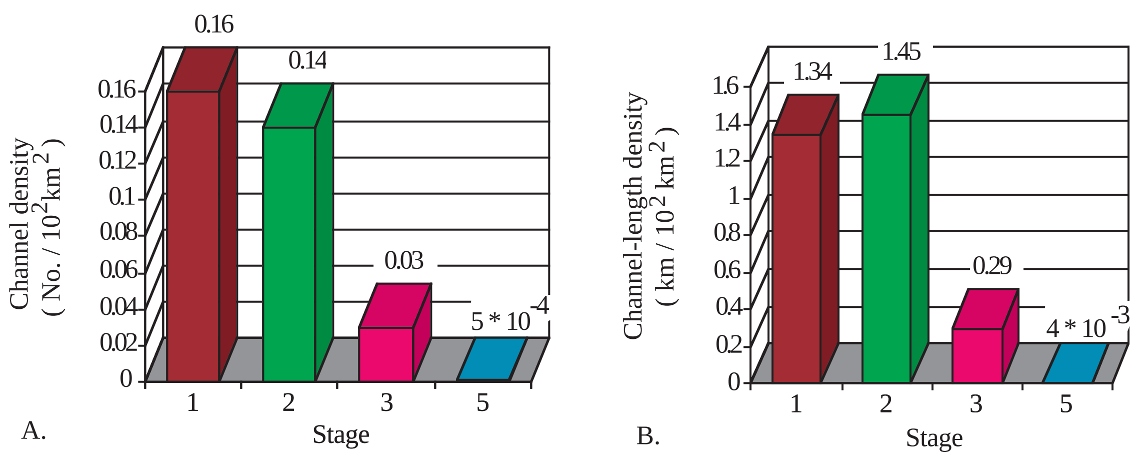

Figure 2. Histograms showing the densities per stage of the (A) number of channels and (B) total channel length of the Thaumasia region. Data from [21].